

ELECTRONIC STATUS MONITORING SYSTEM FOR SECURITY CONTAINERS

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT ROBERT C. HIGGINS, an employee of the United States Government, citizen of the United States of America and a resident of Tiverton, County of Newport and State of Rhode Island, has invented certain new and useful improvements entitled as set forth above of which the following is a specification:

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PATENT TRADEMARK OFFICE

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3 ELECTRONIC STATUS MONITORING SYSTEM FOR SECURITY CONTAINERS
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5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and
7 used by or for the Government of the United States of America
8 for governmental purposes without the payment of any royalties
9 thereon or therefor.
10

11 BACKGROUND OF THE INVENTION

12 (1) Field of the Invention

13 The present invention relates to an electronic monitoring
14 system, and more specifically, to a system for monitoring the
15 removal and attachment of a fastener, such as a locking bar,
16 associated with a security container or cabinet, wherein a
17 signal which is unique for each particular cabinet is sent to a
18 centralized monitoring station which keeps track of the fastener
19 status of all cabinets that are being used no matter where they
20 are located.

21 (2) Description of the Prior Art

22 Containers and cabinets housing confidential, classified or
23 even highly classified material commonly employ safety
24 mechanisms that guard against unwanted exposure of the material

1 being housed to adverse contingencies. A common safety
2 mechanism is a fastener, which may be a locking bar, that is
3 arranged with a locking device so that when the bar is attached
4 to the cabinet the drawers being lodged in the cabinets are
5 prevented from moving outward, thereby, making safe to unwanted
6 exposure of the materials therein.

7 The locking bars serve well their intended purpose, but the
8 actual use thereof suffers practical drawbacks. More
9 particularly, sometimes the locking bar is removed to allow the
10 drawers to be opened and the contents thereof revealed to an
11 authorized person, but sometimes the authorized persons forget
12 to reattach the locking bar to the cabinet, thereby exposing the
13 contents of the cabinet to adverse contingencies. Further, the
14 cabinets are sometimes placed at remote locations preventing
15 them from being viewed during conduct of normal activities,
16 thereby, leaving the contents of cabinets susceptible to
17 uncontrolled viewing. Normally, monitoring these remote
18 ~~locations undesirably involves time-consuming tasks of~~
19 individuals that sometimes suffer from human error drawbacks.

20 It is desired that a monitoring system be provided to determine
21 whether the safety mechanism is in place so as to secure the
22 container or cabinet no matter where the container or cabinet is
23 located.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide for a system for monitoring the status of containers or cabinets housing confidential, classified or highly classified materials.

It is a further object of the present invention to provide an electrical status monitoring system that determines the presence or absence of the security mechanism that ensures the security of a container or cabinet, even if the container or cabinet is located at a remote location.

It is a further object of the present invention to display the security status information of a secured container or cabinet at a central location.

It is a further object of the present invention to provide for an electronic system for monitoring a large number of containers or cabinets containing proprietary or classified documentation located at remote facilities utilized for military or commercial applications.

~~It is a further object of the present invention to provide~~
for a system for monitoring the secured condition of containers or cabinets containing secured information and which does not suffer high labor intensity cost, and human error drawbacks of prior art systems.

In accordance with one aspect, an electronic monitor is provided for detecting the presence and absence of a fastener

1 that secures a cabinet with the presence thereof preventing the
2 opening of one or more drawers being housed in the cabinet. The
3 electronic monitor comprises; (a) a first electrode fixed at a
4 predetermined location of the fastener; and (b) a current
5 sensing network having second and third electrodes located in
6 the cabinet in a predetermined manner so that the first
7 electrode contacts both the second and third electrodes when the
8 fastener secures the cabinet. The current sensing network
9 generates current flow and an output signal when the first,
10 second and third electrodes are in contact and which is
11 representative that the fastener is secured. The electronic
12 monitor further comprises a (c) transmitter connected to the
13 output of the current sensing network and generates a
14 predetermined signal of a selected communication system upon
15 detection of a change in current flow.

16 In accordance with another aspect, an electronic
17 monitoring system is provided for detecting and displaying at a
18 central location the presence and absence of one or more
19 fasteners that respectively secure one or more cabinets with the
20 presence thereof preventing the opening of one or more drawers
21 being housed in each of the one or more cabinets. The
22 electronic monitoring system comprises; (a) a first electrode
23 fixed at a predetermined location on each of the respective
24 fasteners; and (b) a current sensing network for each of the one

1 or more cabinets and having second and third electrodes located
2 on a respective cabinet in a predetermined manner so that the
3 first electrode of a respective fastener contacts both the
4 second and third electrodes of its respective cabinet when the
5 respective fastener secures the respective cabinet. The current
6 sensing network generates current flow and an output signal when
7 the first, second and third electrodes are in contact and which
8 is representative that the respective fastener is secured. The
9 electronic monitoring system further comprises a (c) transmitter
10 located on each of the cabinets and connected to the output of a
11 respective current sensing network and generating predetermined
12 signals of a communication link upon detection of a change in
13 said current flow. Each of the transmitters generates
14 predetermined signals which are different from each other. The
15 electronic monitoring system further comprises a (d) receiver
16 located at the central location and accepting and recognizing
17 all of the different predetermined signals of all of the
18 transmitters and generating respective output signals
19 representative of the presence and absence of respective
20 fasteners attached to respective cabinets.

21

22 BRIEF DESCRIPTION OF THE DRAWINGS

23 The appended claims particularly point out and distinctly
24 claim the subject matter of this invention. The various

1 objects, advantages and novel features of this invention will be
2 more fully apparent from a reading of the following detailed
3 description in conjunction with the accompanying drawings in
4 which like reference numbers refer to like parts and in which:

5 FIG. 1 is a block diagram of the electronic status
6 monitoring system of the present invention;

7 FIG. 2 illustrates a cabinet having a locking bar attached
8 thereto;

9 FIG. 3 illustrates a schematic of the electronics housed
10 on a cabinet associated with the present invention; and

11 FIG. 4 is a block diagram of the receiver of the
12 electronic status monitoring system of the present invention.

13

14 DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 With reference to the drawings, FIG. 1 illustrates an
16 electronic monitoring system 10 for detecting and displaying at
17 a central location 12 the presence and absence of fastener
18 devices including bars, locks and clamps located at a remote
19 location 14 and respectively secured to one or more cabinets 16₁,
20 16₂ ... 16_N, with the presence thereof preventing the opening of
21 one or more drawers being housed in each of the one or more
22 cabinets 16₁, 16₂, 16_N.

23 More particularly, each of the cabinets 16₁, 16₂ ... 16_N has a
24 fastener 18, which in one form may be a locking bar, that

1 secures the contents of a respective cabinet 16 from adverse
2 contingencies and electronics 20 that respectively generate
3 output signals $22_1, 22_1 \dots 22_N$ which represent the presence and
4 absence of a respective fastener 18 securing a respective
5 cabinet 16.

6 Each of the output signals $22_1, 22_1 \dots 22_N$ is accepted and
7 recognized by a receiver 24 at the central location 12. The
8 receiver 24 generates respective output signals of the received
9 signals which are representative of the presence and absence of
10 the respective fastener 18 securing the respective cabinet 16
11 and which are displayed, via signal path 26 to respective
12 indicators $28_1, 28_2 \dots 28_N$ to be further discussed hereinafter with
13 reference to FIG. 4.

14 The purpose of the electronic monitoring system 10 is to
15 determine whether the fastener, such as a vertical locking bar
16 18 for a security container or cabinet 16 is attached or
17 unattached with the attachment thereof preventing the contents
18 of cabinets 16 from being viewed. The status of the
19 attached/unattached locking bar 18 is sent back to a central
20 monitor, more particularly, to receiver 24, which displays the
21 status information. This configuration shown in FIG. 1 may be
22 used in a military or commercial building to monitor the status
23 of a large number of cabinets 16 containing proprietary or
24 classified documentation no matter where the cabinets 16 are.

1 located. In the military where classified information is stored
2 in security containers, such as cabinets $16_1 \dots 16_N$ or in the
3 commercial environment where proprietary information may be
4 guarded, as well as secured, there is a need for a centralized
5 monitoring system, such as the electronic monitoring system 10
6 of the present invention. Further details of the cabinets 16_1 ,
7 $16_2 \dots 16_N$ and fasteners 18_1 , $18_2 \dots 18_N$ may be further described
8 with reference to FIG. 2.

9 FIG. 2 shows one type of cabinet 16 often used for storing
10 classified material having a locking bar 18, which is secured by
11 passing the locking bar 18 through metal brackets 16A and 16B
12 with 16A being below each drawer 32, 34, and 36 and dimensioned
13 to accept and hold the lower portion of the locking bar 18. The
14 top of the bar 18 is inserted through bracket 16B that allows a
15 combination lock 30 to be used to capture and lock the locking
16 bar 18. The interaction of the locking bar 18 with the
17 electronics 20 may be further described with reference to FIG.

18 3, which illustrates the details of the electronics 20 contained
19 in cabinet 16, as well as one embodiment of a guidance assembly
20 assisting the mating of the locking bar 18 to the cabinet 16 and
21 comprising magnets 40A and 40B.

22 In general, the magnet 40A is placed on the cabinet 16 with
23 42 and 44 electrodes attached to the magnet 40A as shown in FIG.
24 3. The other magnet 40B preferably rests on the surface of the

1 locking bar 18 and has an embedded electrode 46 that makes
2 contact with the other 42 and 44 electrodes when the magnets 40A
3 and 40B meet. If desired, the magnet 40B may be embedded in the
4 locking bar 18. The magnet 40B is positioned adjacent and
5 preferably in contact with the electrode 46 and, similarly, the
6 magnet 40A is positioned adjacent and preferably in contact with
7 the electrodes 42 and 44. When the locking bar 18 is put in
8 place, an electrical connection is made between the 42 and 44
9 electrodes in the cabinet 16 and the electrode 46 in the locking
10 bar 18, and current flows through the circuit included in the
11 electronics 20, as shown by directional arrows 48 and 50. When
12 the locking bar 18 is removed, the electrical connection between
13 the first, second and third (46, 42 and 44) is broken and the
14 current becomes 0. The presence of current flow, and more
15 particularly the change in current flow, causes the electronics
16 20 to generate signal 22 and which is representative that the
17 locking bar 18 has either been attached (presence) or unattached
18 (absence) to the cabinet 16.

19 More particularly, with reference to FIG. 3, the first
20 electrode 46 is fixed at a predetermined location on the
21 fastener 18 and the second and third electrodes 42 and 44,
22 respectively are located on the cabinet 16 in a predetermined
23 manner, so that when the locking bar 18 is inserted into the
24 brackets 16A and 16B, the first electrode 46 contacts both the

1 second and third electrodes 42 and 44 providing electrical
2 connection therebetween. Conversely, when the locking bar 18 is
3 removed from the cabinet 16 the electrical connection is broken.

4 Although the magnet 40A, and the bar magnet 40B perform
5 well in assisting the electrical mating of the electrodes 42, 44
6 and 46, other devices may be used. For example, the desired
7 mating may be accomplished by mechanical means, such as
8 extensions from the locking bar 18 mating with cutouts in the
9 cabinet 16. The primary function is to ensure that the first
10 electrode 46 electrically mates with the electrodes 42 and 44 of
11 the current sensing network 52 shown in FIG. 3 when the locking
12 bar 18 is in place.

13 The current sensing network 52 comprises a source of
14 electrical energy that may be selected from the group consisting
15 of a DC battery 54 and AC excitation 56, each of which have
16 first and second ends 58 and 60 respectively. The current
17 sensing network 52 further comprises a current sensor 62, as
18 well as the second and third electrodes 42 and 44 that are
19 spaced apart from each other, with the second electrode 42
20 connected to the first end 58 of the source of electrical
21 excitation. The third electrode 44 is connected to a second end
22 64 of the current sensor 62, which has its first end 66
23 connected to second end 60 of the source of electrical energy.

1 The current sensor 62 has an output 68 connected to the input of
2 a transmitter 70.

3 The current sensor 62 operates in a manner known in the art
4 and upon detection of a change in current flow, generates output
5 signal on signal path 68. The output signal on signal path 68
6 may also activate a status light 72. The electronics 20 may
7 further comprise test 74, which is connected across the
8 electrodes 42 and 44, as shown in FIG. 3. The test switch 74,
9 when depressed, causes current flow which is sensed by current
10 sensor 62 which, in turn, generates an output signal on signal
11 path 68 which, in turn, causes the transmitter 70 to generate
12 the output signal 22.

13 The transmitter 70 generates a predetermined signal of a
14 selected communication link upon the detection of current flow.
15 The predetermined signal is preferably a radio frequency (RF)
16 signal and the communication link may be selected from the group
17 consisting of a frequency shift key (FSK) technique and an
18 amplitude shift key (ASK) technique.

19 In one embodiment, an FSK sequence of pulses is transmitted
20 by transmitter 70 whenever the current sensor 62 senses a change
21 in the magnitude of the current, such as DC current going from 0
22 to a positive (+) quantity, or conversely when the DC current
23 goes from a positive (+) quantity to 0. When the current sensor
24 62 detects a change in the current's magnitude, the RF

1 transmitter 70 is activated and the FSK pulse stream commences.
2 A short sequence of pulses (10 pulses per sequence), each having
3 a duration of 10 milliseconds in one embodiment, provides a high
4 degree of reliability in the receiver 24 detection capability,
5 to be further described hereinafter with reference to FIG. 4.
6 An alerting device 88 of FIG. 4 (also to be further described
7 with reference to FIG. 4) at the centralized status monitor
8 receiver 24 associated with each cabinet $16_1 \dots 16_N$ is initialized
9 at installation to the OFF state when the locking bar 18 is put
10 in place for the first time at its respective cabinet 16. After
11 installation, the alerting device 88 will remain OFF until a
12 sequence of pulses is received, indicating that the cabinet
13 $16_1 \dots 16_N$ has been opened; then, the alerting device 88 will be
14 activated to the ON state. Thereafter, the alerting device 88
15 state will change each time a pulse sequence, in the form of
16 signal 22, is transmitted by transmitter 70 and received by
17 receiver 24.

18 A FSK pulse sequence will be transmitted when the locking
19 bar 18 is either removed or put in place and the electrical
20 connection between electrodes 42, 44 and 46 is either broken or
21 established. A bit switch device, which may be part of each
22 transmitter 70, enables one to set the cabinet identification
23 number (e.g., 001). More particularly, the transmitter 70
24 installed in cabinet 16_1 , may be enabled to transmit the binary

1 code 001, whereas the transmitter 70 installed in cabinet 16₈ may
2 be enabled to transmit the binary code 111. The receiver 24, as
3 well as the alerting device 88, may be further described with
4 reference to FIG. 4.

5 The receiver 24 is shown in FIG. 4, which illustrates an
6 arrangement for handling cabinets 16₁...16₈ where each respective
7 transmitter 70 transmits an output signal 22₁, 22₂, ... 22₈. The
8 receiver 24 comprises an antenna 80, which receives all the
9 different signals from all the transmitters and provides a
10 respective output thereof. The receiver 24 further comprises a
11 band pass filter 82 that is selected to receive and pass all of
12 the predetermined signals 22₁...22₈ that are within the selected
13 band of frequencies of interest. The band pass filter 82
14 provides a respective output for each of its received signals.

15 The receiver 24 further comprises matched filters 84₁, 84₂,
16 84₃, 84₄, 84₅, 84₆, 84₇, and 84₈. Each of the filters 84₁...84₈ is
17 connected to the output of the band pass filter 82 and each is
18 separately selected to receive and pass a particular wave form
19 comprising an output signal and corresponding to a respective
20 transmitter. For example, matched filter 84₁ is selected to pass
21 the waveform that is particular to the transmitter 70 contained
22 in the electronics 20 of cabinet 16₁. Each output of the match
23 filter 84₁...84₈ is routed to a signal processor 86, which provides
24 respective output signals representative of the presence and

1 absence of the fastener 18 being secured to its respective
2 cabinet 16. More particularly, for example, if the signal
3 processor 86 receives a signal from the matched filter 84₁ that
4 received signal represents a current change has been sensed by
5 the current sensor 62 in cabinet 16₁, which, in turn, represents
6 that the locking bar 18₁, has either been removed (absence) from
7 cabinet 16₁, or installed (presence) on cabinet 16₁. The
8 receiver 24 further comprises the cabinet status devices 28₁...28₈,
9 previously discussed with reference to FIG. 1 and each of which
10 comprise an alerting device 88 and a cabinet identification (ID)
11 90, each having a switch 92 and wherein the cabinet ID 90
12 displays the associated binary code, e.g., 000 for cabinet 16₁.
13 Each of the cabinets 16₁...16₈ further preferably are respectively
14 provided with a storage device 94₁...94₈, which tracks the number
15 of pulses received.

16 The arrangement shown in FIG. 4 is associated with a
17 conventional matched filter detector 84₁...84₈ for eight (8)
18 possible FSK signals (1 per cabinet), a storage device 94, which
19 tracks and records the number of detection's in response to the
20 signal processor 86, and an alerting device 88 showing the
21 status of each cabinet 16 locking bar 18.

22 In this embodiment, the storage device 94 changes state
23 when 5 out of 10 pulses are detected. At installation, the
24 unique container identifier and FSK frequency sequence is set by

1 using the digital bit set mechanism shown in FIG. 4, that is, if
2 the locking bar 18 is in place the associated switch 92 is
3 closed. More particularly, for example, if locking bar 18₁ is in
4 place, then switch 92₁ is closed and the cabinet ID 90₁ is
5 energized indicated by binary code (000). This mechanism sets
6 the specific FSK frequency sequence unique to that cabinet. In
7 one configuration, the code is as follows: f1 represents 0 and
8 f2 represents 1. Cabinet 16₁, more particularly its transmitter
9 70, identified as 000 would generate an FSK sequence f1, f1, f1;
10 cabinet 16₂, more particularly its transmitter 70, identified as
11 001 would generate an FSK sequence f1, f1, f2; and cabinet 16₈,
12 more particularly its transmitter 70, identified as 111 would
13 generate an FSK sequence f2, f2, f2.

14 In another embodiment, the FSK RF signal is replaced by an
15 ASK (amplitude shift key) signal. The number of FSK pulses or
16 ASK pulse per sequence may vary. The detection scheme, which
17 was 5 out of 10 in our example, may be redefined all done in a
18 manner known in the art.

19 It should now be appreciated that the practice of the
20 present invention provides for an electronic monitoring system
21 that allows a fastener, such as a locking bar 18 to be used in
22 an arrangement comprising of a large number of cabinets. The
23 monitoring system 10 enables the security person to obtain
24 information about the status of each cabinet 16. The electronic

1 monitoring system 10 of the present invention can be implemented
2 at one location using a computer to display the status of each
3 container which, yields the benefits of saving time and effort
4 commonly expended by security persons in a military or
5 commercial complex.

6 It will be understood that various changes and details,
7 steps and arrangement of parts and method steps, which have been
8 described and illustrated in order to explain the nature of the
9 invention, may be made by those skilled in the art within the
10 principle and scope of the invention as expressed in the
11 appended claims.